- Multiple Choice Review for Chapter 11 & 12
- Text book:
  - Chap 11: pg. 481 #95, 96, 98, 103, 107, 112, 113, 118, 119, 122, 126, 128, 133, 137
  - Chap 12: pg. 522 #100, 102, 110, 116
- Optional: in Study Guide:
  - pg. 221 # 4, 5, **6**, **7**, 15, **19**, 20, 28; pg. 231 # 2, **5**, 10, **12**, **13←Required question**
  - pg. 241 # 8a, **13***, 14, 24, 26 **The answer for this question in the Study Guide is incorrect. See website for a correct solution*

** Underlined questions should be done b/c these types of questions were not in textbook review.

CHAPTER 11: Intermolecular Forces, Liquids and Solids

1) Intermolecular Forces: Stronger intermolecular forces give rise to higher bp's and mp's.
   a) Dispersion: attraction b/w NP molecules or neutral atoms (weak attractions b/w spontaneous and induced dipoles.) The greater the # of electrons, the greater the polarizability and stronger dispersion attractions.
   b) Dipole-dipole attractions: weak attractions between polar molecules (attraction of permanent partial charges.)
   c) Hydrogen Bonding: particularly strong dipole-dipole attractions. Only occurs when the molecule has a hydrogen atom covalently bound to an atom of N, O or F.
   d) Ion-dipole forces: attractions between ions and polar mc's. Smaller, more highly charged ions strengthen this force.
2) Properties of liquids:
   a) Surface tension: The stronger the intermolecular forces, the stronger the surface tension.
   b) Capillary action: Liquids rise in a tube if adhesion is greater than cohesion (Ex: water). Level of liquid is lower in a tube if cohesion is greater than adhesion (Ex: mercury)
   c) Viscosity: Liquids have greater viscosities when mc's have stronger intermolecular forces and/or mc's are more likely to be entangled.
   d) Special properties of water:
      i) Has relatively high mp and bp for a covalent mc because it has strong hydrogen bonds.
      ii) Solid ice is less dense than liquid water because to form ice the mc's must spread out to form the highly stable "hexagonal" structure that is held together with a maximum number of hydrogen bonds.
3) Phase Changes and phase diagrams
   a) Liquid-Vapor Equilibrium:
      i) Equilibrium vapor pressure is reached when rate of evaporation = rate of condensation. For a particular liquid, the (equilibrium) vapor pressure is a constant at a particular temperature (as long as there is some liquid present.) The vapor pressure of a liquid increases with temperature because the rate of evaporation increases with increasing temperature. The stronger the intermolecular forces, the lower the vapor pressure.
      ii) Molar Heat of Vaporization: energy required to vaporize a mole of liquid. (ΔH_{vap} values are always positive because vaporization is always endothermic because bonds must be broken). The stronger the intermolecular forces, the lower the vapor pressure and the higher the ΔH_{vap}.
      iii) Boiling pt: temperature at which the vapor pressure of a liquid is equal to the external pressure. (This is the temperature at which bubbles can form and rise to the surface.) The stronger the intermolecular forces, the higher the ΔH_{vap}, and the higher the bp. Boiling points are higher with higher external pressure (Ex: pressure cooker). Boiling pts are lower with lower external pressure (top of a mountain).
      iv) Critical temperature: above this temperature a gas cannot be made to liquefy no matter how much pressure is applied.
   b) Liquid-Solid Equilibrium
      i) The melting point or the freezing point is the temperature at which the rate of melting (fusion) = rate of freezing.
      ii) ΔH_{fusion} is the energy required to melt 1 mole of solid. (Breaking bonds, endothermic.)
   c) Solid-Vapor Equilibrium
      i) Sublimation—solid goes directly to vapor phase; Deposition—vapor goes directly to the solid phase
      ii) Molar Heat of sublimation is the energy required to sublime 1 mole of solid. $\Delta H_{sub} = \Delta H_{fus} + \Delta H_{vap}$
   d) Heating and Cooling curves:
      i) Know how to label a heating or cooling curve with phases and phase changes. Understand why the temperature stays constant during a phase change.

ii) Be able to do calculations required to determine the amount of energy absorbed/released when a substance is heated or cooled from one temperature to another. (See example on p. 471 of text book)

e) Phase Diagrams

i) Be able to analyze a phase diagram (know phases, mp, bp, triple pt, sublimation pt, etc…)

ii) For most substances the solid-liquid boundary line has a positive slope because most solids are denser than liquids. However, for water, the solid-liquid boundary line has a negative slope because solid ice is less dense than liquid water (When one adds pressure, ice changes to liquid water. Ex: ice skating.)

4) Types of Solids

Amorphous solids—lack regular 3D arrangement of atoms. Ex: glass

Crystalline solids—have a regular 3D arrangement of atoms.

a) Ionic Crystals: 3D lattice of anions and cations. Ions held by strong ionic bonds. Tend to have high mp's and bp's.

b) Molecular covalent crystals: consists of covalent molecules attracted to each other by intermolecular forces. Tend to have relatively low mp's and bp's.

c) Network covalent crystals: held together by an extensive 3D network of covalent bonds. Tend to have relatively high mp's and bp's. Common examples are graphite, diamond and quartz (SiO_2), metalloids

i) Diamond: an allotrope of carbon. Consists of sp^3 hybridized carbons that make strong sigma bonds throughout network. Thus, diamond is very hard and has a high mp ($3550^{\circ}C$). (It does not conduct electricity.)

ii) Graphite: the other allotrope of carbon. Consists of sp^2 hybridized carbons. All unhybridized p orbitals overlap throughout each layer. Thus, electrons are delocalized (free to move), so graphite conducts electricity. Layers are held together by weak dispersion attractions (Thus, graphite is a good lubricant).

iii) Semiconductors are metalloids with a low concentration of free electrons so low conductivity

(1) Increasing temperature increases conductivity by increasing KE of electrons (for conductors, conductivity decreased due to increased vibrations of the crystal lattice)

(2) Conductivity is increased by doping—adding a small amount of an impurity. Adding an impurity with extra valence electrons makes the material n-type (negative because electrons are moving), adding one with fewer valence electrons creates p-type material (positive because "holes"—missing electrons—are moving).

d) Metallic crystals: consists of all metal atoms. Since valence electrons are held weakly by metal atoms, one can describe metallic crystals as consisting of an array of cations immersed in a sea of delocalized valence electrons. Thus, metals are good conductors.

Chapter 12: Solutions

1) Types of solutions: saturated, unsaturated and supersaturated. (Know how to make a supersaturated solution and how to disturb it.) Be able to analyze a solubility curve to determine solubilities of substances.

2) The solution process (dissolving): break solvent-solvent attractions (endo), break solute-solute attractions (endo) and then make solute-solvent attractions (exo). Thus, overall, the solution process can either be endothermic or exothermic. Generally, "like dissolves like."

3) Effect of temperature on solubility:

a) Generally, the solubility of solids increases with increasing temperature (see solubility curves).

b) The solubility of gases decreases with increasing temperature (again, see solubility curves).

4) Concentration units: Know definitions of percent by mass, mole fraction and molarity.

5) Effect of pressure on the solubility of gases:

a) The solubility of gases increases with increasing external pressure (When there is greater external pressure, more gas molecules strike the surface of the liquid. Thus, gas molecules are more likely to dissolve.)

~~b) Be able to make calculations using Henry's Law: s = kP~~

6) Colloids: an intermediate state between a true homogeneous mixture and a true heterogeneous mixture. There is a "dispersed" phase suspended in another substance. Ex: aerosols (fog), emulsions, gels, hydrophilic colloids (proteins fold to allow polar parts of protein to be surrounded by water), hydrophobic colloids (non-polar molecules such as fats can be suspended in water with the help of soap like substances.)